State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

STANDING STOCKS OF FISHES IN SECTIONS OF INDIAN CREEK, PLUMAS COUNTY, 1982

Bay-Delta Project
Contract Services Section

By

Dawn Kori Bumpass
Graduate Student Assistant

Karen Smith
Seasonal Aid

and

Charles Brown, Jr.
Associate Fisheries Biologist

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INTRODUCTION

In 1976, the Northern District of the Department of Water Resources (DWR) initiated an instream flow program to identify streams that would benefit from flow enhancement to assess instream values and identify trade-offs required to enhance these streams. Indian Creek below Antelope Reservoir (Figure 1) was selected as one of the streams to study under this program. Initial flow studies by DWR indicated that flow augmentation could double trout habitat in the first 16 km of Indian Creek below the dam and increase habitat by 25% in lower reaches (DWR, 1979). As a result of this study, DWR and the Department of Fish and Game (DFG) decided to reoperate Antelope Reservoir in March, 1978 to increase flow releases from 0.1 cms to 0.6 cms year-round on a trial basis (Hinton and Haines, 1981). These flow changes were constrained by a requirement that recreation at Antelope Reservoir would not be impaired.

The role of the Contract Service Section in this study is to monitor fish populations in selected sections of Indian Creek and assist DWR personnel in determining fishing effort and catch in the creek. Previous studies of this stream have described fish populations and growth statistics (Brown 1978, Brown and Haines 1979, Haines and Brown 1980, Villa and Brown 1981, Villa 1982). This report describes sections of the creek sampled, fish species caught, and fish biomass at each station, during September, 1982.

METHODS

Standing stocks of fishes were estimated at six stations (each containing riffles and pools) in Indian Creek. Stations were located in the first 21 km of Indian Creek below the dam (Figure 1). Stations were intentionally selected to be near stations sampled in previous DFG studies (Appendix 1). Markers were placed in trees along the stream to permanently identify station boundaries for future sampling. Each station had similar physical characteristics as the

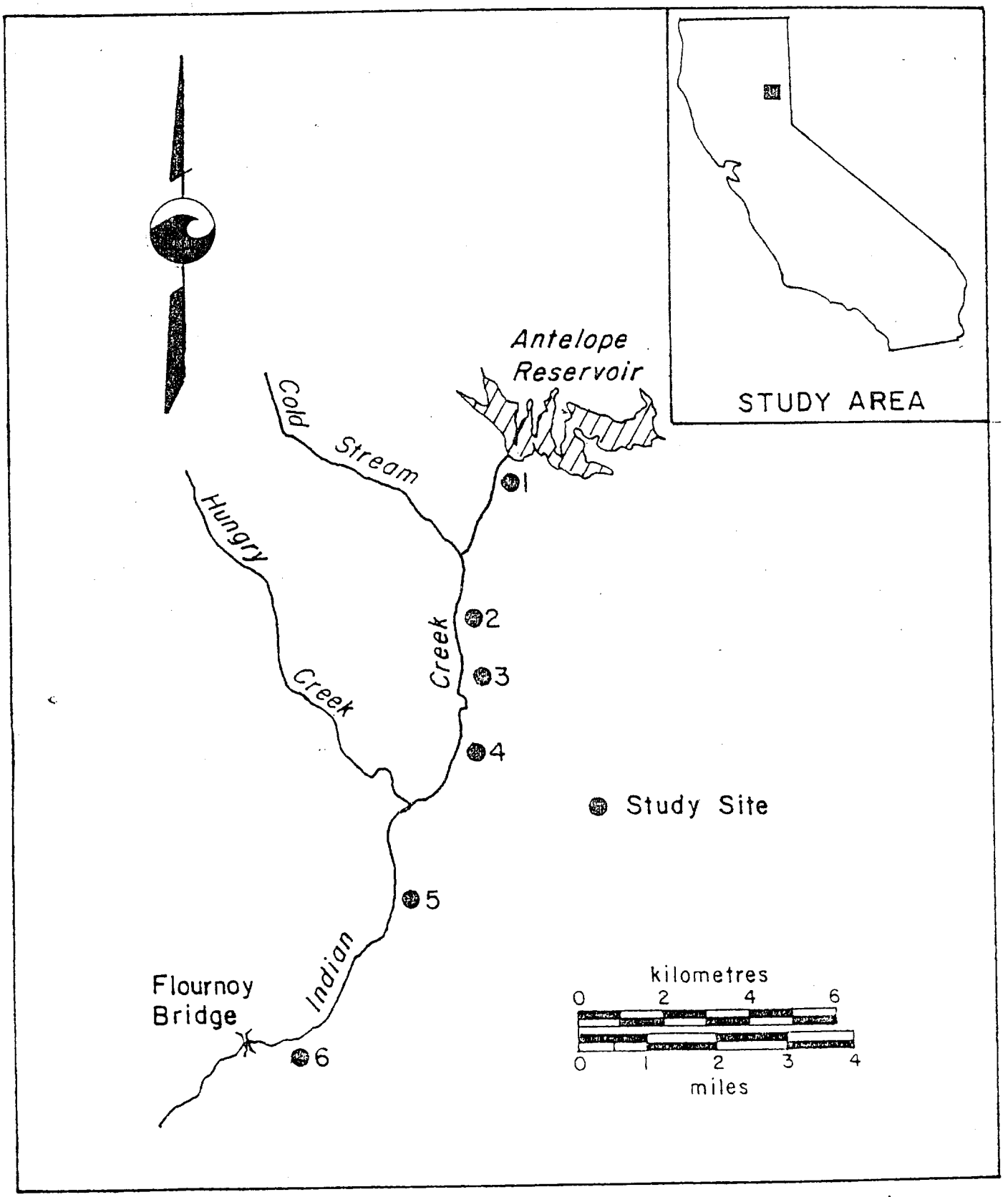

Figure 1 - Stations sampled to determine biomass of fishes in Indian Creek, Plumas County, September 1982.

stream reach in which it was located. Stations varied in length from 34 to 74 m, and the length, average width, and percentage of riffles and pools average depth, of each station were measured. Each stream section was blocked with seines. Fish were sampled with a battery-powered backpack electroshocker (Smith-Root, Type V11), (Appendices 2 and 3). Captured fish were removed from the net-enclosed section of each pass. Standing stock estimates were developed using the two-count method of Seber and Le Cren (1967) or the multiple-pass method of Leslie and Davis (1939) with limits of confidence computed using a formula proposed by De Lury (1951).

The weights of brown trout (Salmo trutta) and rainbow trout (Salmo gairdneri) were determined by displacement. Weights were not measured for brown bullhead (Ictaluras nebulosus), green sunfish (Lepomis cyanellas). Lahontan redside (Richardsonius egregius), Sacramento squawfish (Ptychocheilus grandis), Sacramento sucker (Catostomous occidentalis), and hardhead (Mylopharodon conocephalus). Fork length of most brown trout and rainbow trout was measured to the nearest millimetre. Some trout escaped. Fish other than trout were not measured.

Trout scales were dry mounted between microscope slides, and their images were projected on a NCR microfiche reader at a magnification of 42X. Scale measure- ments for the calculation of growth were recorded to the nearest millimetre along the anterior radius of the anterior-posterior axis of the scale.

Geometric mean functional regressions were used to describe the body-scale and length-weight relationships (Ricker, 1975). Estimation of true mean growth rate (G) was calculated using the methods of Ricker (op. cit.). Predictive regressions were used to describe the body-scale and length-weight relationship (Ricker, 1975).

RESULTS

Distribution

Brown trout were caught at every station; rainbow trout were caught at all stations except 2 and 4. Brown bullhead were caught at stations 1, 3, 4 and 5, while green sunfish were caught at stations 1 and 5. Lahontan redside were found only at station 1. Sacramento squawfish, Sacramento suckers and hardhead were found only at station 6 (Table 1).

TABLE 1. Distribution of Fishes in Sections of Indian Creek, Plumas County, 1982

	Station Number					
	1	2	3	4	5	6
Distance below Antelope Dam (km)	0.6	3.9	5.3	6.8	12.3	21.0
Brown trout	X	X	X	X	X	X
Rainbow trout	X		X		X	X
Brown bullhead	X		X	X	X	
Green sunfish	X				X	
Lahontan redside	X					
Sacramento squawfish						X
Sacramento sucker						X
Hardhead						X

Standing Crop

Brown trout were the most common game fish caught in Indian Creek. Total brown trout biomass averaged 4.60 g/m^2 at six stations. Biomass for brown trout large enough for fishermen to catch and keep (127 mm FL) averaged 4.46 g/m^2 (Table 2). Total rainbow trout biomass averaged 1.25 g/m^2, while the biomass for catchables averaged 1.06 g/m^2 (Table 3).

TABLE 2. Estimate of Brown Trout Standing Crop in Indian Creek, Plumas County, 1982

Distance Below Antelope Dam (km)	Population Estimate	95% Confidence Interval	Biomass g/m	Estimate of Catchable Trout (127 mm Mean Fork Length)	Biomass of Catchable Trout g/m
0.6	40	36-44	5.68	31	5.93
3.9	56	51-61	8.35	50	7.34
5.3	41	40-43	8.41	41	8.41
6.8	16	15-17	3.07	12	2.95
12.3	22	21-23	1.14	21	1.13
21.0	4	0-12	0.93	3	1.02
			x = 4.60		x = 4.46

TABLE 3. Estimates of Rainbow Trout Standing Crop in Indian Creek, Plumas County, 1982

Distance Below Antelope Dam (km)	Population Estimate	95% Confidence Interval	Biomass g/m	Estimate of Catchable Trout (127 mm Mean Fork Length)	Biomass of Catchable Trout g/m
0.6	53	47-59	3.07	15	2.38
5.3	2	2	0.52	2	0.52
12.3	26	25-28	0.16	5	0.11
21.0	8	3-14	1.23	6	1.21
			x = 1.25		x = 1.06

Brown bullhead was the most common non-salmonid fish caught in Indian Creek (Table 4). Biomass averages were not calculated for brown bullhead, green sunfish, Lahontan redside, Sacramento squawfish, Sacramento sucker, or hardhead, since individual fish weights were not recorded for nongame fishes.

TABLE 4. Estimates of Population of Nongame Fishes in Indian Creek, Plumas County, 1982

Distance Below Antelope Dam (km)	Species	Population Estimate	95% Confidence Interval
0.6	Brown bullhead	1	1
0.6	Green sunfish	4	0-11
0.6	Lahontan redside	18	18
5.3	Brown bullhead	3	3
6.8	Brown bullhead	1	1
12.3	Brown bullhead	56	54-58
12.3	Green sunfish	18	0-54
21.0	Sacramento squawfish	1	1
21.0	Sacramento sucker	23	22-24
21.0	Hardhead	2	2

Age and Growth

The equation L = 7.6 + 4.0 S describes the relationship between the fork length (L) and enlarged scale radius (S) of 281 brown trout caught in Indian Creek. The coefficient of correlation (r^2) is 0.86. The equation was L = 11.5 + 4.5 S for 62 rainbow trout caught in Indian Creek, while the value for r^2 is 0.76.

Growth rates for 1+ brown trout were faster for population growth than for mean individual growth (Table 5). Age 1+ rainbow trout had a faster growth rate for mean individual growth than for population growth (Table 6). There was insufficient age class data for further growth rate analysis for both rainbow trout and brown trout from Indian Creek.

TABLE 5. Growth Rates for Brown Trout Caught in Indian Creek, Plumas County, 1982

	Population Growth			Mean Individual Growth		
Age Interval	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx
1-2	99-196	0.683	2.11	106-195	0.610	1.88

TABLE 6. Growth Rates for Rainbow Trout Caught in Indian Creek, Plumas County, 1982

Age Interval	Population Growth: Length Interval (mm)	Population Growth: Difference of Natural Logarithms	Population Growth: Instantaneous Growth Rate Gx	Mean Individual Growth: Length Interval (mm)	Mean Individual Growth: Difference of Natural Logarithms	Mean Individual Growth: Instantaneous Growth Rate Gx
1-2	115-189	0.497	0.447	106-189	0.578	0.520

Two 7+ brown trout were caught. These fish averaged 604 mm in fork length. One 5+ brown trout was caught and measured 560 mm in length. Three 4+ fish averaged 470 mm, 3+ fish averaged 303 mm, and 2+ fish averaged 228 mm in fork length; 1+ fish averaged 163 mm, while 0+ fish averaged 105 mm in fork length (Table 7).

TABLE 7. Calculated Fork Length in Millimetres of Brown Trout from Indian Creek, Plumas County, 1982

Age	No. of Fish	Mean Fork Length at Capture (mm)	Calculated Lengths at Successive Annuli: 1	2	3	4	5	6	7
1	214	163	99	-	-	-	-	-	-
2	42	228	106	196	-	-	-	-	-
3	3	303	112	204	293	-	-	-	-
4	3	470	109	220	315	393	-	-	-
5	1	560	92	172	284	391	457	-	-
7	2	604	90	167	249	330	417	487	562
Number of back-calculations			265	51	9	6	3	-	2
Weighted means (mm)			100	196	290	372	430	487	562
Increments (mm)			100	96	94	82	58	47	75

One 2+ rainbow trout was caught in Indian Creek and measured 245 mm in fork length. Forty six 1+ fish were caught and averaged 159 mm, while 0+ fish averaged 96 mm in fork length (Table 8).

TABLE 8. Calculated Fork Length in Millimetres of Rainbow Trout from Indian Creek, Plumas County, 1982

Age	No. of Fish	Length at Capture (mm)	Calculated Lengths at Successive Annuli 1	2
1	46	159	115	-
2	1	245	106	189
Number of back-calculations			47	1
Weighted means (mm)			115	189
Increments (mm)			115	74

Age group 0+ brown trout represented 8.6% of the catch. One + fish made up 73.7% and 2+ fish represented 14.5% of the catch. Three + and 4+ brown trout each made up 1.5%, 5+ fish represented 0.4%, and 7+ fish made up 0.8% of the catch (Figure 2). Age group 0+ rainbow trout represented 58% of the total catch, while 1+ and 2+ made up 41.4% and 0.9%, respectively (Figure 3).

Length and Weight

The relationship between length (L) and weight (W) of brown trout is:

$$\text{Log}_{10}W = {}^{-}4.91 + 2.97\ \text{Log}_{10}L$$

$r = 0.99$

$r^2 = 0.98$

N = 336 (Figure 4) (Appendix 2)

The same relationship for rainbow trout is:

$$\text{Log}_{10}W = {}^{-}4.97 + 3.01\ \text{Log}_{10}L$$

$r = 0.99$

$r^2 = 0.98$

N = 118 (Figure 5) (Appendix 3)

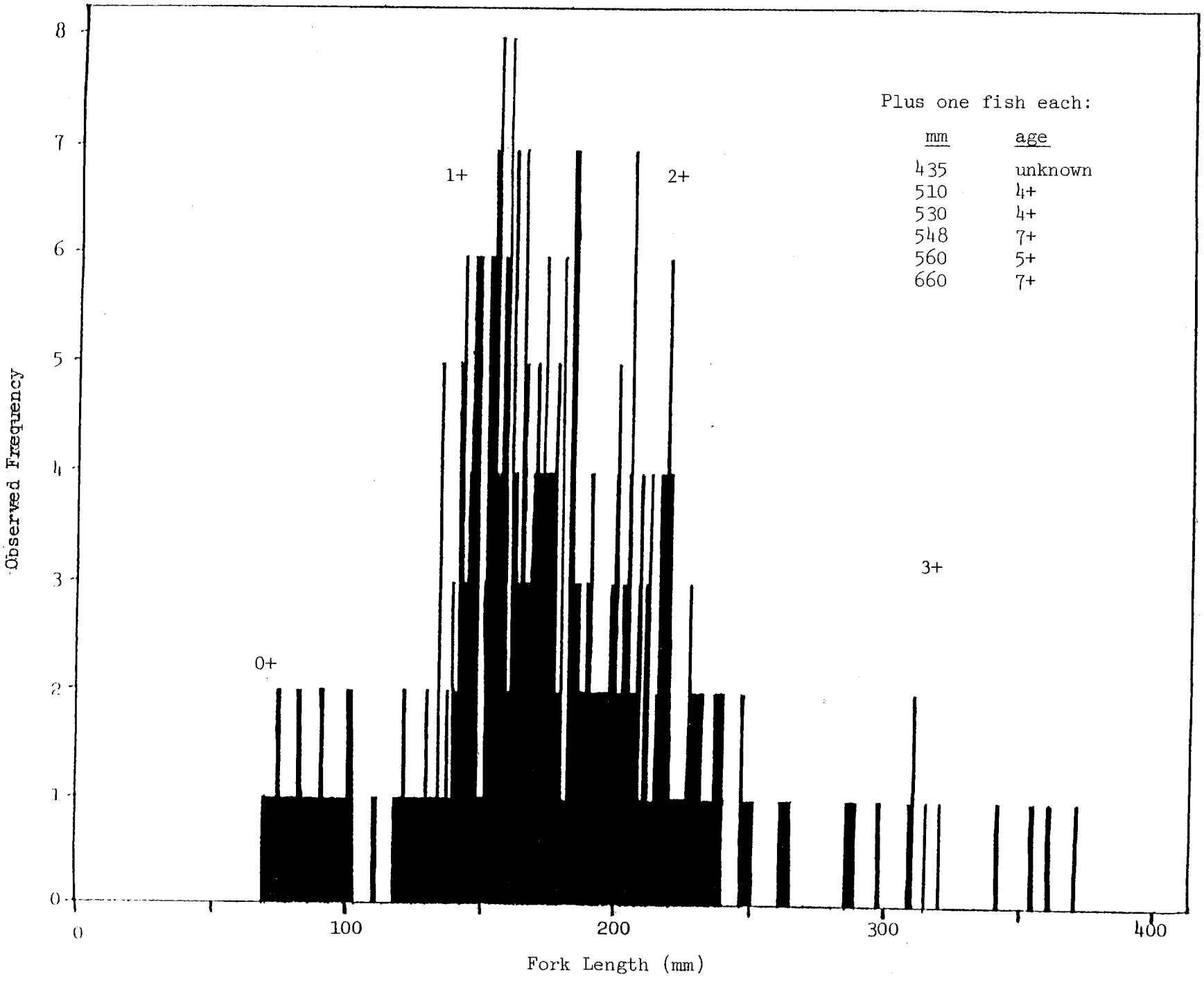

FIGURE 2 Length, observed frequency, and age of brown trout caught in Indian Creek, Plumas County, 1982.

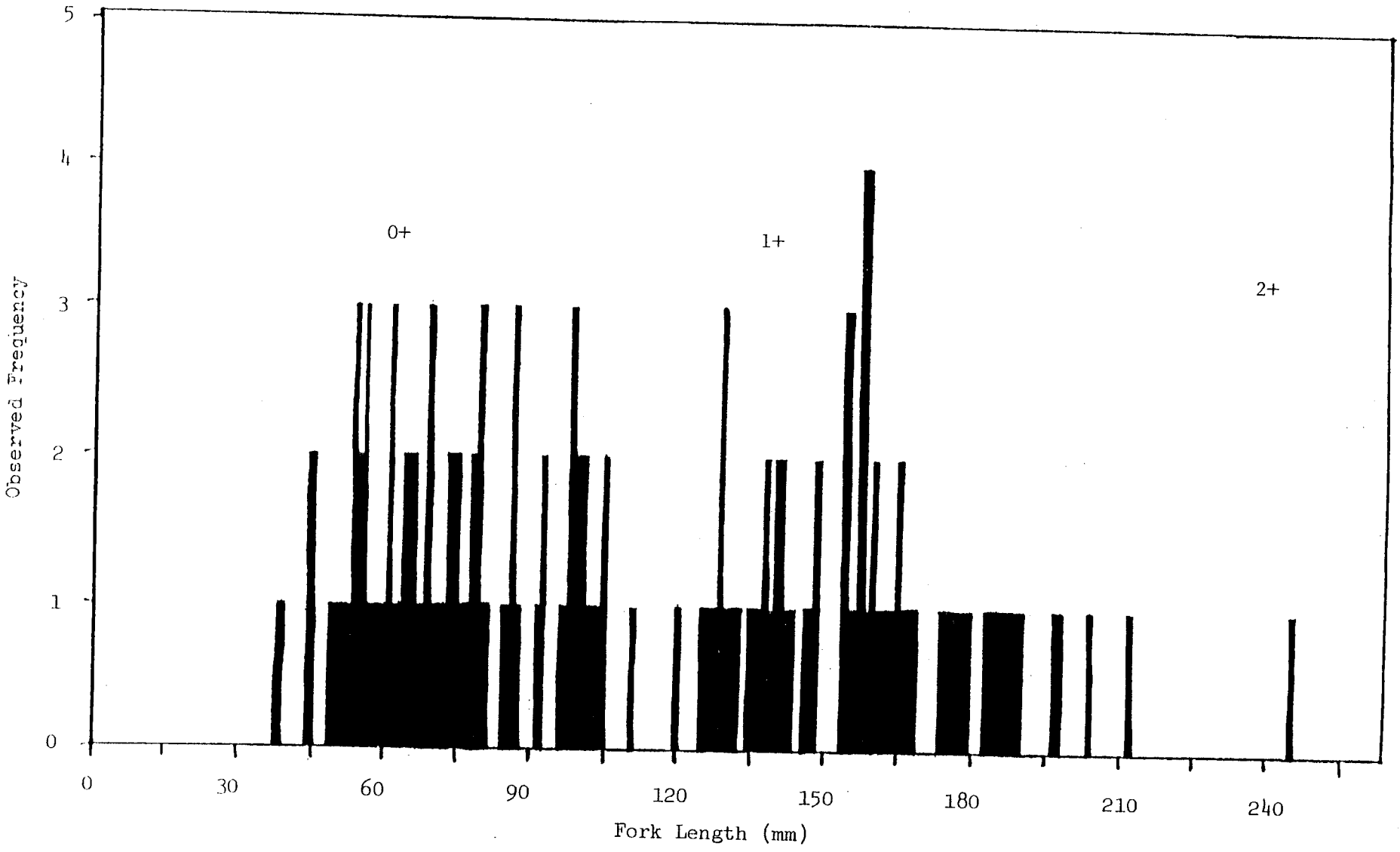

FIGURE 3 Length, observed frequency, and age of rainbow trout caught in Indian Creek, Plumas County, 1982.

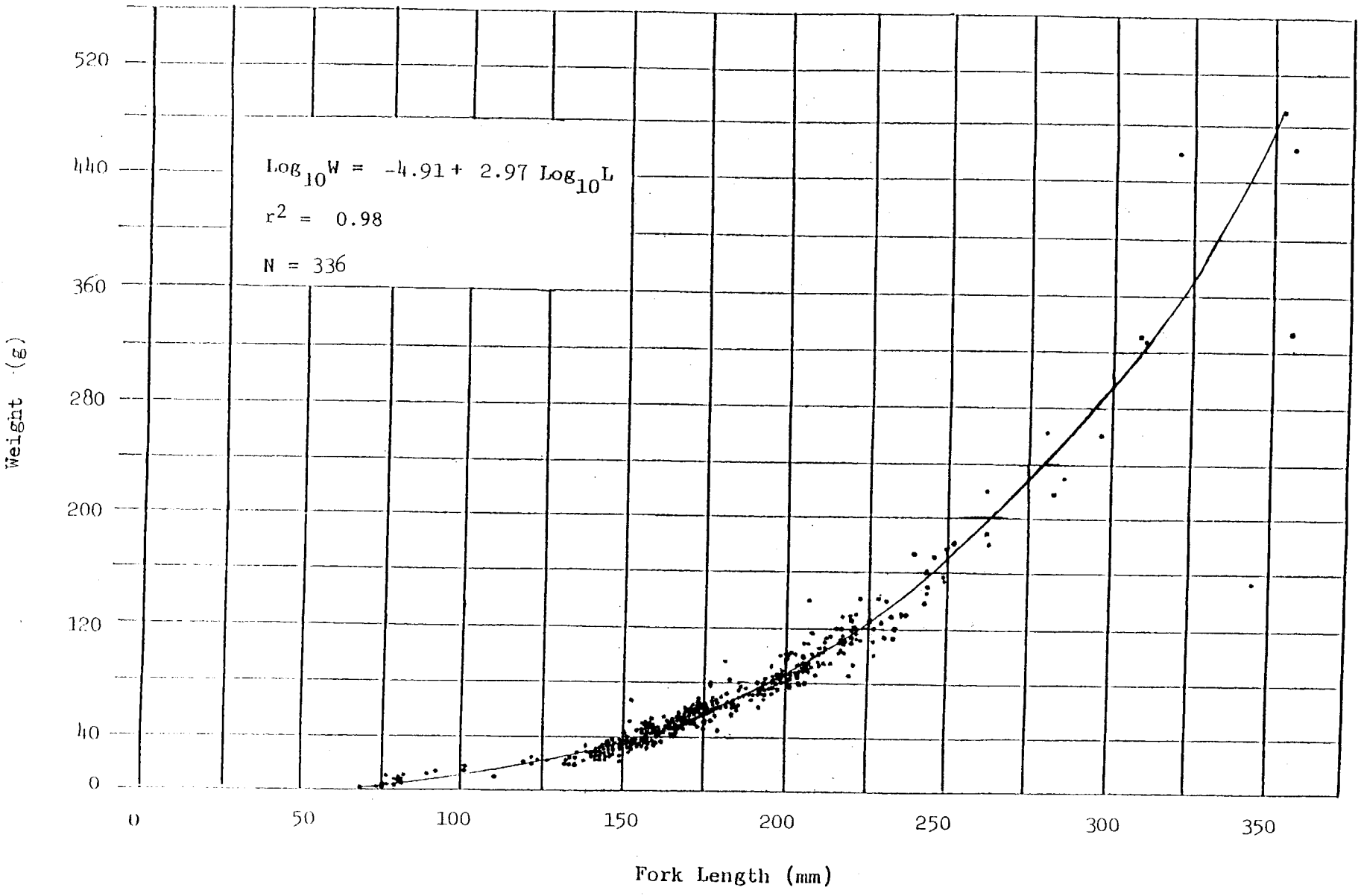

FIGURE 4 The relationship between length and weight of brown trout caught in sections of Indian Creek, Plumas County, 1982.

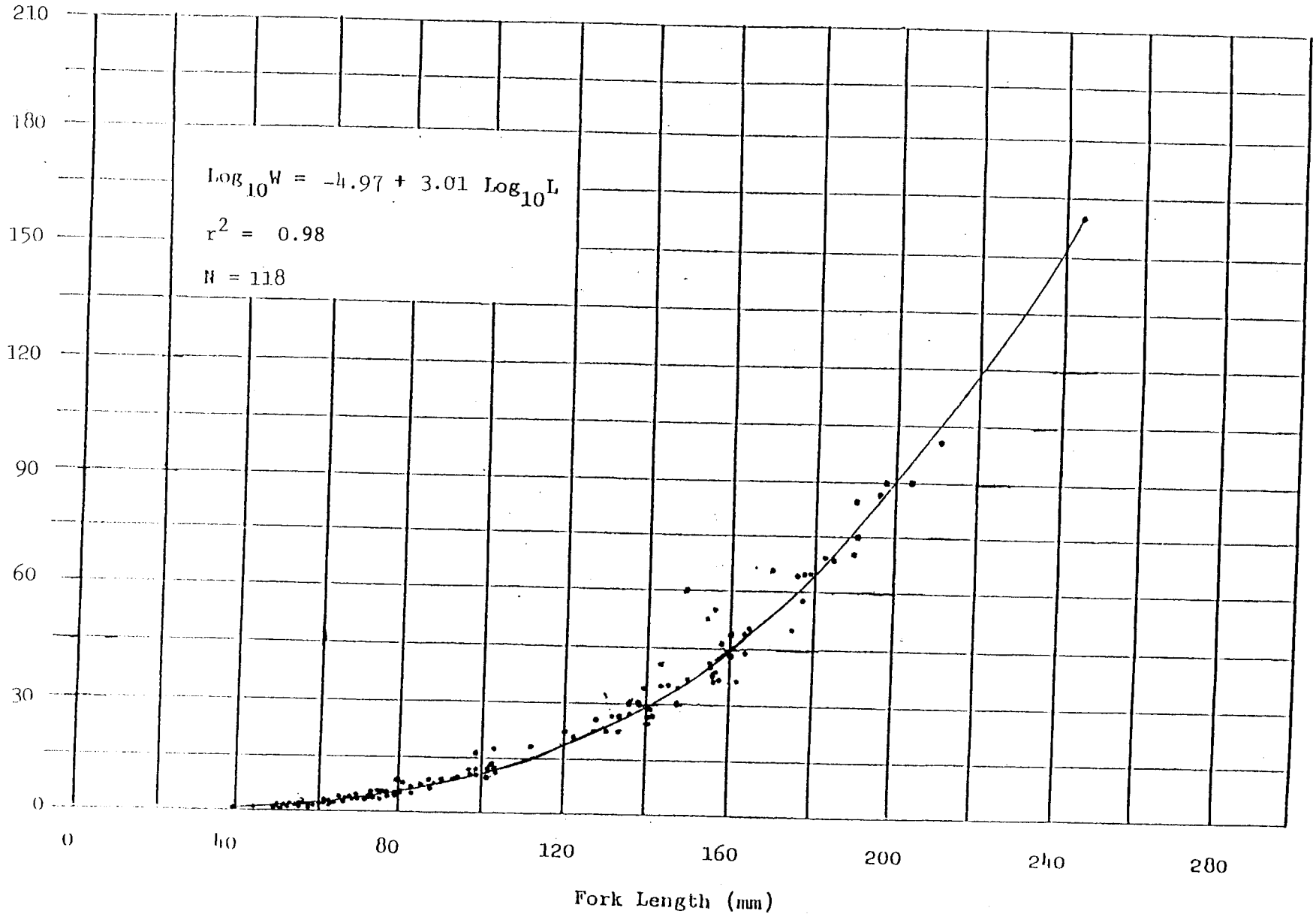

FIGURE 5 The relationship between length and weight of rainbow trout caught in sections of Indian Creek, Plumas County, 1982.

Coefficient of Condition

We calculated the coefficient of condition and 95% confidence limits for 244 brown trout and 112 rainbow trout (Table 9).

There is no significant difference between the coefficient of condition for any age group of rainbow trout or brown trout we tested ("t" test, 0.05 level).

TABLE 9. Condition of Brown Trout and Rainbow Trout in Indian Creek, Plumas County, 1982

Age Group	Number of Fish	Coefficient of Condition	95% Confidence Interval
Brown trout			
0+	21	1.0791	0.9293 - 1.2289
1+	181	1.0774	0.8828 - 1.2720
2+	40	1.0983	0.8853 - 1.3113
3+	2	1.0290	0.8756 - 1.1824
Combined	244	1.0795	0.9736 - 1.1854
Rainbow trout			
0+	65	1.1634	0.7845 - 1.5423
1+	46	1.1424	0.8092 - 1.4756
2+	1	1.1559	
Combined	112	1.1487	1.1145 - 1.1829

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APPENDIX 1

PERMANENT FISH POPULATION STATIONS
INDIAN CREEK, PLUMAS COUNTY
SEPTEMBER 1982

APPENDIX 1

PERMANENT FISH POPULATION STATIONS
INDIAN CREEK, PLUMAS COUNTY
SEPTEMBER 1986

Station 1 - Located 0.6 stream km below Antelope Dam adjacent to the picnic area near the junction of Indian Creek Road and the spur road leading to the base of the dam (NE 1/4 of NE 1/4, Section 27, T27N, R12E). The station consists of a riffle (40%) and a long pool (60%). This station has been modified from previous years by a beaver dam constructed downstream which has turned the wrong portion of the station (formerly riffle) into a deep pool. The station has a surface area of 764 m^2 and a volume of 291 m^3 at 0.6 cms.

Station 2 - Located 1387 km above Flournoy Bridge, 1.9 km below Cold Stream, and about 3.9 km below Antelope Dam (SW 1/2 of SW 1/2, Section 34, T27N, R12E). The station extends 35 m from a 36-cm-diameter alder (RB) downstream to a 10-cm-diameter pine (RB). Both are marked with metal disks, which can be seen from the road. The station contains riffle (65%) and shallow pool (35%) areas. It has a surface area of 310 m^2 and a volume of 101 m^3 at 0.6 cms.

Station 3 - Located about 11.5 km above Flournoy Bridge, 3.7 km above Hungry Creek, and about 5.3 km below Antelope Dam (NW 1/4 of NW 1/4, Section 10, T26N, R12E). The lower end of the station is about 29 m upstream from the upper end of a parking turnout. The station extends 40 m upstream from a 38-cm-diameter alder (RB) to a 28-cm-diameter pine (RB). Both are marked with metal disks, which can be seen from the creek. The section contains a riffle area, which enters a 0.9-m-deep pool followed by a riffle and a shallow pool. (Riffle area totals 40%, pool area 60%.) It has a surface area of 284 m^2 and a volume of 106 m^3 at 0.6 cms.

Station 4 - Located 10.9 km above Flournoy Bridge and about 6.8 km below Antelope Dam (NW 1/2 of SW 1/4, Section 10, T26N, R12E). Upper end of station is just downstream from a drainage ditch at the lower end of a parking turnout located 0.3 km above Babcock crossing. Station extends 40 m downstream to the end of a riffle just above a long, shallow pool. It contains riffle (55%) and shallow pool (45%) areas with a small amount of undercut bank (RB). It is not marked with metal disks. The station has a surface area of 328 m^2 and a volume of 65 m^3 at 0.6 cms.

Station 5 - Located at an unimproved campground about 5.5 km upstream from Flournoy Bridge and about 12.3 km below Antelope Dam (SW 1/4 of SW 1/4, Section 21, T26N, R12E). The station extends 70 m upstream from the lower end of a riffle area with several grassy hummocks (Transect 3 of the fish habitat evaluation study). Metal disks remain on a small willow at the lower end (LB) and a large elder snag at the upper end (RB) mark the station. The station contains a riffle and shallow run area, a shallow pool with undercut bank (RB), and a riffle area. (Riffle area is 60%, pool area 40%.) It has a surface area of 685 m^2 and a volume of 169 m^3 at 0.6 cms.

Station 6 - Located about 0.9 km upstream from Flournoy Bridge and about 21 km below Antelope Dam. Drive 0.3 km east of Flournoy Bridge and take the paved spur road to the right. Drive 0.6 km to a gate in the fence on the right side of the road. Follow trail from gate downstream 85 km along creek where alders on RB end and a steep riffle enters a pool. The lower end of the station is at the top of the steep riffle. The station extends 40 m upstream and is marked with metal disks on 10-cm-diameter alders (RB). The disks are hard to find because there are lots of alders along the right bank. The upper half of the station is a riffle and shallow pool, followed by a rocky run and a small pool in the lower half. (Riffle area totals 45%, pool area 55%.) The station has a surface area of 372 m^2 and a volume of 107 m^3 at 0.6 cms.

APPENDIX 2

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK
SEPTEMBER 1982

APPENDIX 2

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK, SEPTEMBER 1982

Length (mm)	Weight (g)	Length (mm)	Weight (g)
69	4	156	38,44,50
73	4	157	36,42,42,
75	4,5		44,46
76	4.5	158	36,39,39,
77	7		39,44,50
79	4.5	159	42,42
80	6.5	160	43
82	6,7	161	40,46,46,
83	5.5,5.5		46,50,58
89	7	162	43,44,48
91	8	163	44,48,50
95	10	165	43,45,46,48,
101	10,12		50,52,52
111	14	166	44,48,48,
119	16		48,52
122	17,19	167	41,48,50
123	21	168	50,50
128	21	169	50,51,52
133	21	170	50,51,53,
134	23,23,23,26		56,60
135	26	171	48,54,57,58
136	30	172	50,58,60,62
137	25	173	57,60,60,
138	24		62,64,67
139	27,27,30	174	58,60,65
140	28	175	54,54,59,60
141	28,31,32,32	176	55,60,60,62
142	29,29,31,	177	60,66,66,80
	31,33	178	60,60
143	30,30,31,34	179	54,60,62,
144	28,32,36		62,66
145	32,32,34,35	180	65
146	32,35,35,36	181	72
148	26,33,34	182	61,62,65,
149	31,34,35,35		68,75
150	46	183	58,60,61,66,
151	34,35,35		70,75,95
152	30,32,35,	184	75,82
	38,39,40	186	66,70,70
153	34,35,44,	188	63,70
	50,65	189	70,73,80
154	35,36,38,	190	68,82
	39,46,46	191	70,75,80,85
155	30,38,39	192	70,76
	40,45,48		

APPENDIX 2 (cont'd.)

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK, SEPTEMBER 1982

Length (mm)	Weight (g)	Length (mm)	Weight (g)
193	79,90	221	110
194	75,80	222	140
195	77,80	225	125
196	75,85	227	110,110,120
198	80,85,100	228	115,140
199	80,85,85,90	229	125,130
200	80 80,80,	231	110
	97,105	232	120,135
201	85,105	235	150
202	90,90,92	237	130,170
203	90,100	238	160
204	80,90,92,100	239	140,150
205	80,84,85,	240	145
	88,90,95,95	247	160,170
206	90,110	249	155
207	95,100	250	175
208	85,95,115	251	180
209	95,105,	261	190
	110,140	263	180
210	95	264	220
211	93,105,105	285	220
212	95,105	286	230
	115,115	288	260
214	105	297	260
215	110,120	309	325
216	85,110,	310	330
	120,130	320	460
217	105,110,110	341	151
218	95,110,115,	353	490
	115,120,130	354	460
219	125,125	360	330
220	110,110,	435	900
	115,120		

APPENDIX 3

LENGTH AND WEIGHT OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK
SEPTEMBER 1982

APPENDIX 3

LENGTH AND WEIGHT OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK, SEPTEMBER 1982

Length (mm)	Weight (g)	Length (mm)	Weight (g)
39	0.6	125	20
45	1,1.4	129	22,22,24
49	0.9	131	25
50	1.8	132	22
52	1.6	135	34
54	1.6,1.6,1.9	136	30
55	1.8,2	138	26,30
56	1.8,2,2	139	34
57	1.8	140	25,27
59	1.9	141	28,29
60	2.2	142	40
61	2.2,2.4,3	143	35
63	2.6	146	34
64	2,4	147	30
66	3,4	148	36,60
67	3.5	154	36,36,54
69	3.5,4,4	155	40
71	3.5	156	41
72	3.5	157	40,40,42,55
73	4,4	158	46
75	5,5	160	42,48
76	3.5	161	36
78	5,5	163	48
79	4,6,8	165	44,50
80	5	168	65
81	9	174	50
84	7	176	62
85	7	177	58
86	7,8,9	178	64
87	6	179	64
91	8	183	70
92	8,8.5	185	66
96	10	187	70
97	12	188	85
98	10,12,16	190	75
101	9,12	197	88
102	12	198	90
103	13	204	90
105	12,17	212	100
111	17	245	170
120	21		

APPENDIX 4

METRIC CONVERSION FACTORS

APPENDIX 4

METRIC CONVERSION FACTORS

Quantity	Metric Units	Divide by	English Units
Length	millimetres (mm)	25.4	inches (in)
	centimetres (cm)	2.54	inches (in)
	metres (m)	0.3048	feet (ft)
	kilometres (km)	1.6093	miles (mi)
Area	square metres (m^2)	0.0929	square feet (ft^2)
Volume	cubic metres (m^3)	0.7646	cubic yards (yd^3)
Flow	cubic metres per second (cms)	0.0283	cubic feet per second (cfs)
Biomass	grams per square metre (g/m^2	8.92	pounds per acre (lb/acre)